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Interfacial Fluid Mechanics with Heat Transfer and Phase Change

Omar K. Matar
Department of Chemical Engineering, Imperial College London
o.matar@imperial.ac.uk

Interfacial flows have been a constant source of fascination for centuries. The complex dynamics of interfaces are at the heart of so many industrial, biomedical, natural, and daily-life settings, and span decades of length and time scales. These include the formation of wave patterns in film flows, nano- and microfluidics, coating flows, intensive processing, pipeline transportation of oil-and-gas, and crude-oil processing. Heat transfer and phase change can introduce significant complexities over and above those associated with isothermal multiphase flows. Several examples will be presented. These will include the non-isothermal rise of a bubble in a self-rewetting fluid, and the (super-) spreading of a drop of this fluid on inclined substrates. We will also show that evaporation in sessile drops can lead to spontaneous pattern formation exemplified by the development of convective rolls, and, in certain cases, hydrothermal waves. We will also demonstrate that fouling in crude-oil heat exchangers is associated with complex dynamics resulting from the delicate interplay between heat transfer, turbulent multiphase flow, and phase change arising from phase-eparation and chemical reactions. Finally, opportunities for future research avenues will be highlighted.